FINAL REPORT

BRAILLE TEACHING AND COMMUNICATION SYSTEM

15 November 1965

HUGHES

HUGHES AIRCRAFT COMPANY

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FINAL REPORT

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HUGHES AIRCRAFT COMPANY

TECHNICAL INTERNAL CORRESPONDENCE

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Braille Teaching and Communication System

FROM: D. L. Hirsch
29-48-20

BLDG. 6 MAIL STA. D133
EXT. 2323

RACT:

Blind persons must communicate with their environment through the senses of touch and hearing. When the latter sense is diminished or lacking, the tactile sense becomes of prime importance. Blind persons now read and write using the Braille System of printing and writing in which letters, numerals and punctuation are made of raised dots distinguished by the finger tips.

While braille books are now produced in quantity as are various manually operated braille writing devices, these are primarily intended to facilitate communication with the blind. The Braille Teaching and Tactile Communication System proposed as a result of preliminary investigation under the Division 27 Hughes Personal Innovation Program does not only enhance communication with the blind. It also serves as a powerful device for teaching the blind and also the sighted, how to communicate through the sense of touch.

This is accomplished primarily with a "tactile readout". The reader rests his fingertips on the surface of a readout plate. Braille "cell" configurations electromechanically reproduced on the surface of the plate impinge on his fingers. This process simulates the reading of a braille book but in a comparatively intensified and accelerated manner.

Two of the methods proposed for activating the tactile readout are:

1. A sensor or switching complex similar to a typewriter keyboard which activates the tactile readout directly or which programs magnetic tape.

2. A tape transport and storage system which handles magnetic tape programmed with information that is converted into braille signals by the tactile readout.

Background information requested on the technical and psychological aspects of braille reading has been received from authoritative sources such as the Sensory Aids Center at the Massachusetts Institute of Technology and the American Foundation for the Blind. These communications point to the need for the proposed system.

If it appears promising, the Braille Teaching and Tactile Communications System should lead to a new product line for the Hughes Aircraft Company.

While the study has already resulted in considerable insight into the field of tactile communications, additional understanding of man-machine relationships is needed to make the most of the proposal concept. Related studies in pertinent areas of psychology and physiology are required.

A promising avenue would be to investigate the use of tactile communications for manned spacecraft and deep submergence vehicles. This approach would investigate hardware which utilizes tactile displays.

Man's senses were evolved to enable him to cope with the terrestrial environment. New concepts in sensory discrimination must be considered when the environment undergoes change or modification as in underwater or outer space orientations. Reflection on the potentialities of the subject matter should reveal the need for initiating pertinent studies.

PURPOSE

The purpose of this report is to present an insight into the problems and problem areas associated with the development of communications and display presentation techniques used by the visually handicapped. A descriptive approach to a tactile communication and display system is presented here. The system includes devices for input, storage and output of information. This work was done by the

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INTRODUCTION

Since the introduction of braille over a century ago the technique of reading has changed but slightly. The fingers are used for sensing patterns of raised dots, embossed on the surface of various materials. The materials consist of substances such as various grades of paper stock, metal, plastics, etc. The braille dots are usually embossed on the surface of the paper although in some instances the dots consist of plastic substances deposited in the desired configuration on paper sheets.

Those concerned with problems of the blind are aware of recent advances in engineering technology which alleviate many problems of the visually handicapped. These include the use of computers and data processing systems for the rapid and economical production of braille books. They also include the development of electronic guidance systems. However, such developments are outside the scope of this program.

The prime objectives of this program are to:

1. Produce an optimum system for teaching braille to the blind and the deaf-blind.
2. Provide a method of communication between blind or deaf-blind and sighted persons.
3. Promote self reliance and self-sufficiency of visually handicapped people through the development of special instrumentation as vocational aids.

Characteristics of the Blind Person

As a prelude to the investigation of hardware concepts it seemed mandatory to develop an insight into, and an understanding of, the persons to be served. Blind people are classified as either congenitally blind or adventitiously blind. The congenitally blind are those persons who were born without vision. The adventitiously blind are those, who although born with vision, have lost all or part of their sight either

gradually or suddenly as the result of disease or mental trauma. The adventitiously blind, unlike the congenitally blind, had some degrees of visual experience and are able to develop a mental concept of visual ramifications such as color, light, movement, form, perspective, shading, etc. This points up one of the multitudinous problems of teaching reading in braille namely, visualization. What significance, for example, do such terms as "red" or "bright" hold for a congenitally blind person reading these symbols in braille?

Blindness varies in degree, ranging from total blindness to a state of partial vision classed as "legal blindness". In most states "legal blindness" is defined as a condition of central visual acuity in the better eye which with correction does not exceed 20/200; that is, at 20 feet the legally blind can recognize symbols and objects which a person with normal vision can recognize at a distance of 200 feet. In addition, the peripheral vision in the better eye is limited so that the peripheral field has contracted to such extent that the widest diameter of visual field subtends an angle no greater than 20 degrees. Limited peripheral vision is also referred to as "gun barrel" vision.

Visually handicapped persons differ primarily from sighted persons in that their reaction to all environmental factors is attenuated by the loss or minimization of vision. Other senses such as touch and hearing are then relied upon to a maximum extent for perception of environmental stimuli. This has resulted in the widely held fallacy that a blind person's hearing level for example, will be more acute than that of sighted persons. Actually the visually handicapped persons will place greater reliance on these other senses and in so doing becomes more discriminate in utilizing them.

Just as blindness is not an absolute condition, the blind person should not be considered a sterotyped individual. Mentally and physically he is the same as his normally endowed fellow human beings. He undergoes, as in the case of sighted persons, the same psychological and physiological processes which are somewhat modified however, due to his inability to see.

Braille and Its Application

In teaching braille, consideration must be given to certain conventions associated with the reading of Romanized characters which are read horizontally from left to right, and progressing downward on the printed or written page. Other languages such as the Chinese language must be phonetically transcribed into Romanized characters for reading in braille.

The proposed braille teaching and communication system is intended to serve people with all degrees of blindness. Concepts or principles which would interfere on conflict with accepted techniques of reading or teaching braille are avoided. However, it must be realized that braille is not necessarily the optimum system of sightless reading. Rather it is the best available reading system now in wide use throughout the world.

The Braille System

The Braille System of reading uses an alphabet of dots. Each letter is formed from a basic cell. The basic cell contains six dots arranged in two parallel vertical columns of three. For teaching purposes the dots are numbered from one to six starting with the upper left hand position. Dots in the left column are numbered from one to three in descending order. Dots in the right column are numbered from four to six, also in descending order. Letters, arabic numerals, dipthongs, punctuation marks, contractions, etc., are formed by using different combinations of dots in each embossed cell. The dots in the braille cell are arranged as in Figure 1. The distance between the dots of a single cell is 0.090 inch; between each braille cell, 0.160 inch; between each letter, 0.250 inch and between each line of braille, 0.220 inch. These distances are measured from dot center to dot center as shown in Figure 1.

The braille cells are usually embossed on one side of the sheet only which adds to the bulk when hand embossing is done; however, braille produced by press methods can be interpointed or pressed on both sides of the sheet in such an arrangement that dots do not oppose

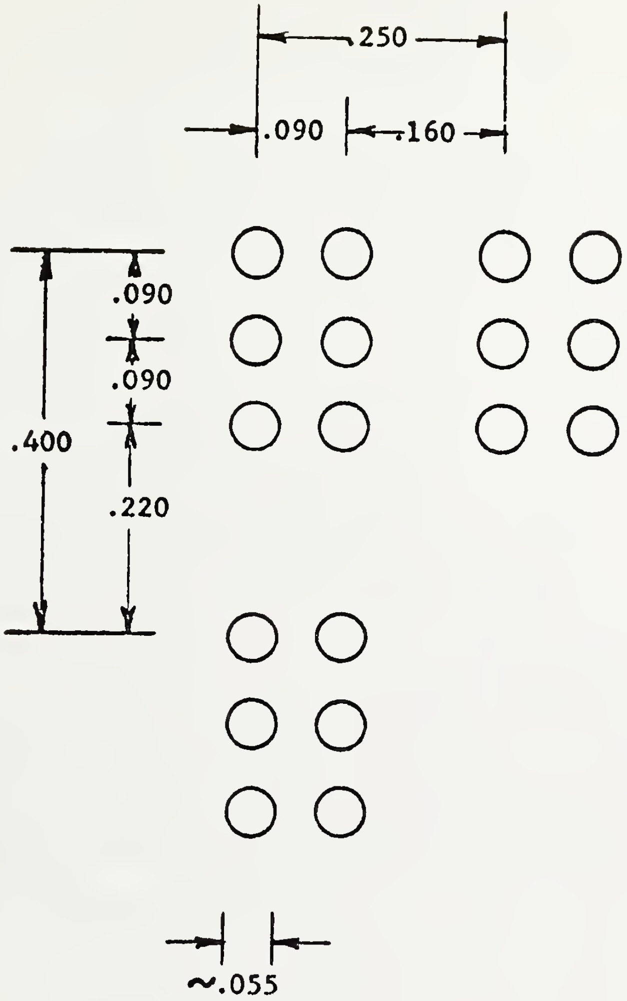


Figure 1. Standard Braille Dimensions drawn five times actual size. All dimensions in inches.

and thereby "cancel" each other. The dots are embossed approximately 0.015 inch above the surface of the undisturbed paper and have a diameter at the base of the dot of 0.555 inch. These dot orientation and presentation dimensions will be utilized in the readout device described later in this report.

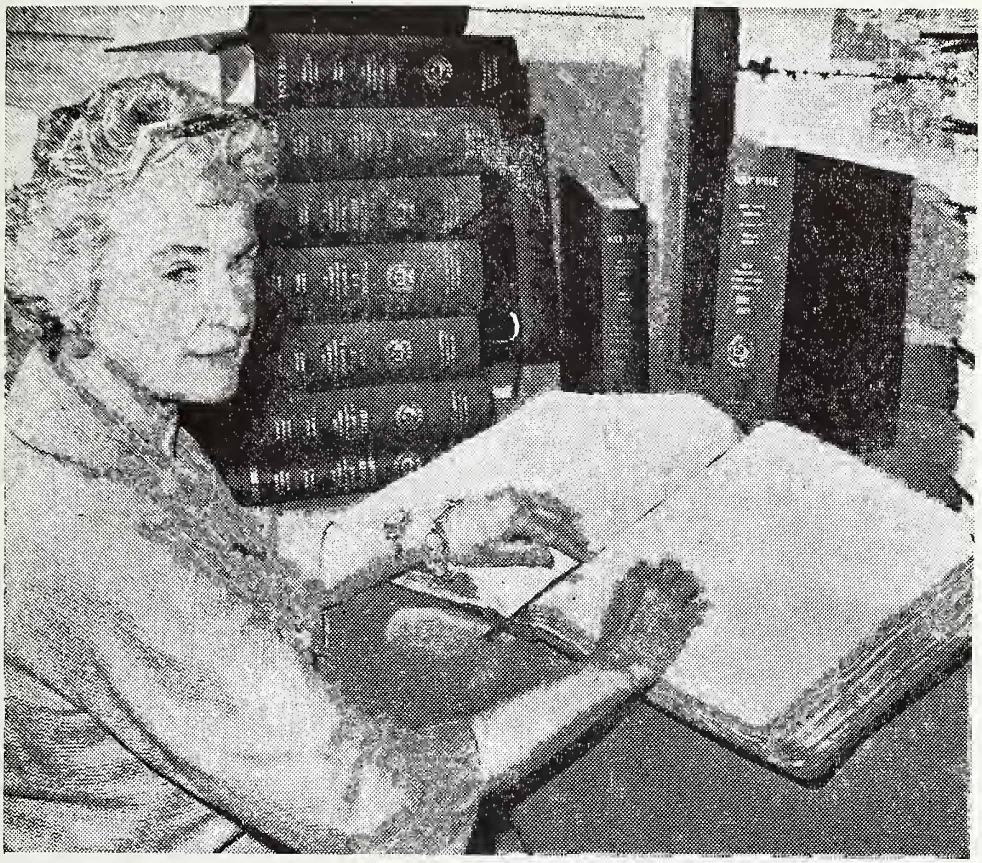
The book printed in braille will be larger than the ink print edition because the braille cell is larger than the average ink printed letter and each page must be thick enough to retain the raised dots through many readins. Figure 2 shows the voluminous size of the braille version of the King James Bible.

There are three versions or "grades" of braille writing. Grade One braille is fully spelled out. It consists of letters of the alphabet and symbols for punctuation, capitalization and the numerals. Grade Two braille, a kind of shorthand uses approximately 200 contractions, i.e., symbols which represent groups of letters, whole words, and parts of words. Grade Three braille has an even higher number of contractions. The average reader of braille is slowed down by the high degree of contractions in grade three braille and finds grade two braille most rapid. The essential advantage of increasing magnitude in grades of braille is the ability to write faster as in the case of speed writing for visual reading.

English speaking countries have developed a compromise version of braille known as Standard English Braille, (Grade Two) which contains 185 contractions. This system was adopted in 1932 and rules were set up to insure uniformity in embossing. Grades Two and Three serve to reduce the bulk of braille volumes by use of contractions. Standard English Braille is used for music as well as for language text. When applied to such fields as music and mathematics the braille dot combinations of course, have different meanings. Figure 3 shows the complete alphabet, along with many of the braille symbols used for contractions, punctuation, etc.

Engineering technology appears to have done very little in the way of developing new systems or devices that will replace the "eye-printed page" system. Most worthwhile research and development contributions

Sec. F—SUN., OCT. 17, 1965 Los Angeles Times



BIBLE IN BRAILLE—Miss Evelyn Weldon, blind instructor of the Braille Institute, reads Braille version of King James Bible. She studies volume before stack of 19 others it takes to print the Bible in Braille. It takes 85 hours to read.

Times photo

Figure 2. Massive volumes are required when standard text material is transcribed into Braille.

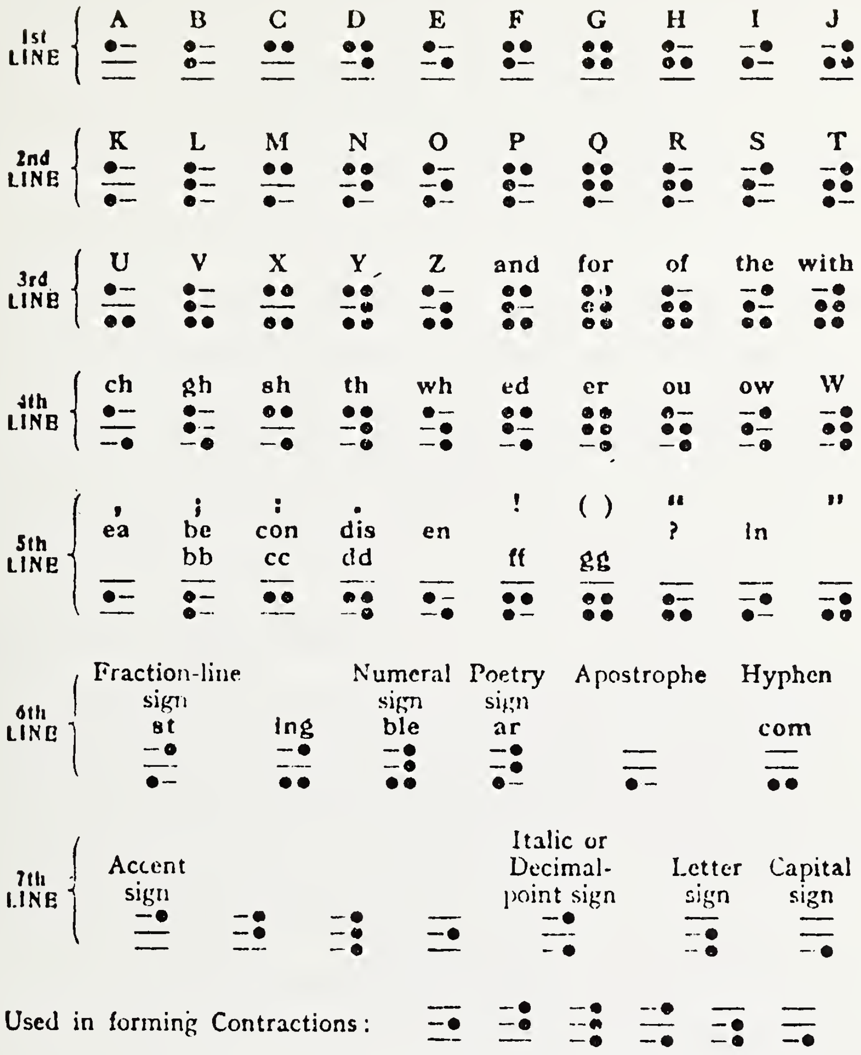


Figure 3. The Braille alphabet.

toward providing an adequate reading capability for the blind have been directed at facilitating the mass production of braille publications. The development of devices or systems of direct use to the blind individual has received scant attention, yet there is a major need for devices or systems that will either help the blind read faster or will help them to learn to read braille more easily and more quickly. There is also a real need for a device that will increase the perceptual span of the blind person.

The perceptual span refers to the area of encompassment of indiscriminate random bits of information. For a sighted person this includes the total field of vision. Among visually handicapped persons the perceptual span is either curtailed to some degree or is completely eliminated. In this case the perceptual span must be defined in terms of tactile perceptive procedures.

Physiology of the Tactile Sense

Since the blind are dependent on either the sense of touch or hearing instead of on the sense of sight, any device intended to communicate information to the blind must utilize either of the two senses. Since the subject of this proposal will utilize the tactile sense it is desirable to look briefly at the physiology of this sense.

The skin is the prime transfer medium for the sense of touch. In addition to its other physiological functions, the skin serves as a complex sensory network; sensitive to such external stimuli as temperature, pressure, and the relative motion of contacting surfaces. The outer skin or epidermis contains nerve endings, tactile corpuscles and blood vessels. The tactile corpuscles and similar structures located in surface tissues are classified as organs of touch. They are sensitive to simple pressure and give rise to images of form as a result of the various pressures presented by uneven surfaces and gross contours. The environmental factor stimulates the tactile organ causing transmission of a nerve impulse to some nerve center and from this point may influence appropriate reactions of the person or may be stored in memory.

The tactile corpuscle consists of an elliptical bulb about 0.0033 inch or less in length enclosed in a connective sheath and partially separated by plates of the same tissue. From one to several course nerve fibers enter the corpuscle and follow a winding course inside, ending between or on the connecting tissue cells. These tactile corpuscles are especially abundant on the skin of the finger tips and in other places where the sense of touch is highly developed. Hence there is no reasonable doubt as to their function. Other tactile corpuscles of more limited occurrence also exist and are supplemented in the skin by free nerve endings some of which expand into disc-like nets. Touch or tactile sensibility enables us to appreciate by actual contact the size, form and consistency of objects and the character of their surfaces. Regions of the skin exhibiting the greatest sensitivity occur in the margin of the lips, the tip of the tongue, the palms of the hands and under the surfaces of the fingers. Some writers speak of "general sensibility" as one of the senses, and include under this term touch, muscular sense or the sense of pressure, temperature, etc.

THE BRAILLE COMMUNICATION SYSTEM CONCEPT

The Braille Communication System consists of an input device or transmitter, a tape storage and transport device, and a display device or tactile readout. The system is outlined in Figure 4. The input device is used for "keying" the braille signal to either the storage device or the output device. The tape storage and transport device holds the encoded magnetic tape if such is utilized. The display device or tactile readout serves to receive the electrical impulse from either the input device or the tape storage device and converts the impulse to the tactile mode. The input device and the readout device are the two main elements of the system and they will be developed simultaneously before the magnetic tape storage and transport system is considered.

Elements of the Input Device

1. Sequential contactor (switching) assemblies, modular
2. Relays, electrical or mechanical latching

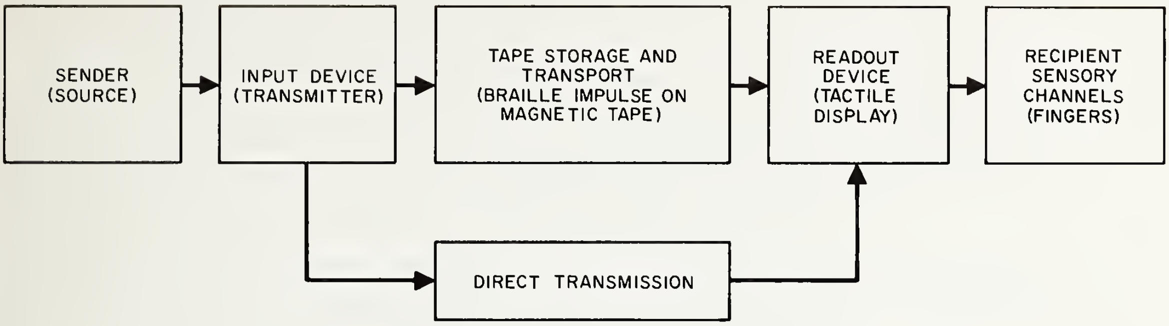

SENDER (SOURCE)
INPUT DEVICE (TRANSMITTER)
TAPE STORAGE AND TRANSPORT (BRAILLE IMPULSE ON MAGNETIC TAPE)
READOUT DEVICE (TACTILE DISPLAY)
RECIPIENT SENSORY CHANNELS (FINGERS)
DIRECT TRANSMISSION

Figure 4. The Braille teaching and communication system concept.

3. Etched circuit boards, as required
4. Envelope, connections and hardware
5. Low voltage direct current power supply

Function of the Input Device

1. Programming of storage media (magnetic tape)
2. Direct keying of tactile readout

Elements of the Tactile Readout Device

1. Solenoid and actuator subassembly
2. Forward pulsing and detent switch
3. Reverse pulsing and detent switch
4. Pulse rate control
5. Envelope, connections and hardware

Function of the Tactile Readout Device

The tactile readout device receives the electrical impulses from either the input device directly or through the magnetic tape storage system. The impulses are translated into tactile sensations which are transmitted to the finger tips of the reader.

The Directly Coupled Input-Readout System

The directly coupled input-readout system functions in the following manner.

1. System de-energized; all readout device solenoids are in down or "no display" position.
2. Encoding key depressed; readout device solenoids energized in accordance with character representation of specific encoding key.
3. Encoding key released; braille cell dot array remains on readout device until succeeding character is generated by depressing the same key or another key.

The braille cell consists of six dots. Each dot is activated on the readout device by its own solenoid hence six solenoids must be individually activated to create the desired braille cell presentation. The electromechanical function which each dot in the cell undergoes is shown in Figure 5.

Depending on the particular cell array to be presented, each key is programmed to activate from one to six dots. The order of activation, whether simultaneously or in some sequence, will be determined during the evaluation by human subjects.

Requirements for Timing of the Display Cycle

The display or readout presentation rate is determined by the following factors:

1. Array of dots in braille cell
2. The number of cells constituting a word

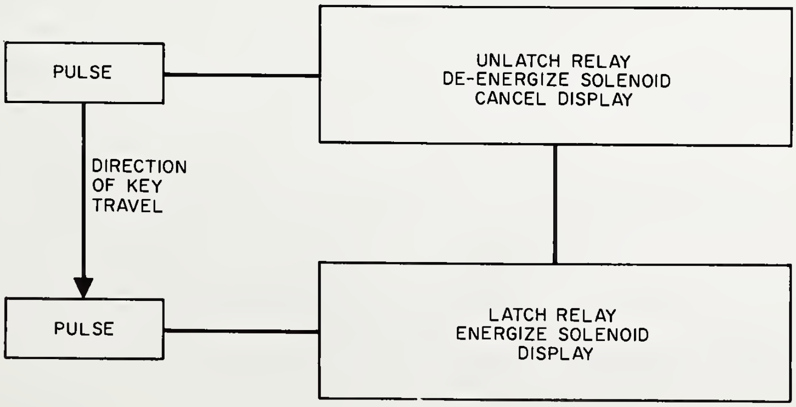


Figure 5. Unit solenoid switching cycle.

3. The usage of punctuation, numbers, etc.
4. The use of contractions in place of spelled out words.

The assumptions to be made regarding the maximum display capability are that the average word has six letters, the reading rate for Grade Two braille is 60 to 120 words per minute, and that from one to six dots will be displayed with each braille cell presentation.

One hundred twenty words per minute is equal to 12 letters per second. Each letter will therefore be displayed for 83 milliseconds. Some readers of braille can read as fast as 300 words per minute but this is considered exceptional. The practical readout device must be capable of presenting the characters at a rate compatible with the reading ability of the subject. Electromechanical components such as relays and solenoids which will be used to activate the readout device are now available with response times that are repeatable within the range of from three to ten milliseconds which is well below the comprehension time of the average human reader.

Engineering Design Concepts for the Input Device

The input device design concepts involve the use of printed circuitry. The printed circuit board will be the functional module base and it serves the following purposes:

1. The mounting pad for relays, capacitors, diodes or other components required by the circuitry.
2. The interconnection network which minimizes the amount of wiring and simplifies the circuitry.
3. The etched conductor serves as contact surface for relays and switches where design permits.

The printed circuit specifications are tentatively these:

1. Base Material: - 0.065 inch glass cloth epoxy or 0.093 inch XXXP paper base laminate
2. Conductor: - 1 or 2 ounce copper (0.0014 to 0.0028 inch thick)

3. Plating: - 20 to 50 microinches of Rhodium over 50 microinches Nickel plating; can be confined to coil lead, switch contact and relay contact areas.

The system is designed to operate on 24 volts direct current obtained from a 115 volt alternating current prime source. The 115 volt alternating current will be stepped down with a transformer having a rated output of 24 volts center tapped and one ampere. A full wave rectifier bridge converts the alternating current to direct current. Capacitors or other applicable components will be incorporated into the circuit if it is necessary to establish specific delay time values in some phase of the switching cycle. Other components will be incorporated in accordance with circuit design requirements. The switching mechanism can be integrated with the printed circuit board whereby portions of the board circuitry, properly designed and plated, may serve as switch contacts.

The encoding key is connected to the switch which will be activated by a light force that is approximately equal to, or greater (by a predetermined amount) than the force needed to actuate the key on an electrical typewriter. The switch is linearly actuated an electrical contact occurs during the "push" phase of the switch operation. Contacts can be effected either simultaneously or in some established sequence during the "push" phase. No contact is made during the "return" phase of the switching stroke. If arcing occurs in any of the contacts during the actuating cycle, suitable arc suppression components will be added if necessary.

The input device switching complex actuates the latching relays which in turn switch the energizing current to the solenoids.

Each solenoid is activated by its own relay. The relay is activated by the switch which makes a contact that allows a current pulse to flow through the relay coil. The relay may be latched by electrical magnetic or electromechanical means. It would be preferred to have the relay in a non-energized state during the latching phase. The magnetic latching type of relays is considered less trouble prone than the mechanical latching relay. For the application outlined here,

relays having operating times ranging from 3 to 7 milliseconds will be considered as this range is compatible with the actuating times of the matching solenoids.

Packaging Concepts

1. Input Device (See Figure 6). The packaged assembly of the input device is a switching complex designed to resemble the keyboard and case of a portable typewriter without the movable carriage. The input device keyboard is arranged in four stepped rows similar to a typewriter keyboard. Each row is a "module" of the required number of keys. The comparison between the braille keyboard and that of a standard typewriter are shown in Figure 6a as follows:

The standard typewriter keyboard arrangement will be preserved on the left portion of the keyboard. The 20 additional characters which tentatively make up a braille keyboard of 63 characters will be added to the right of the standard keyboard. It will be necessary to evaluate this arrangement to show feasibility and to compare with braille keyboards on existing braille typewriters.

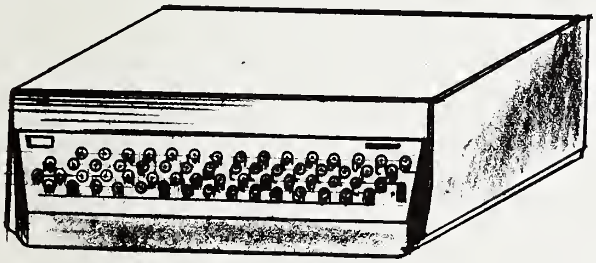


Figure 6. Representation of Braille input device showing case and keyboard arrangement.

ROW (FROM TOP)	NUMBER OF KEYS	
	STANDARD TYPEWRITER KEYBOARD	BRAILLE KEYBOARD
1	10	15
2	11	16
3	12	17
4	10	15
TOTAL	43	63

Figure 6a. Comparison of keyboards.

The number of parts comprising the switching complex will be kept to a minimum through standardization of design for all elements comprising the switch assemblies. Assembly techniques will be simplified to keep the fabrication and material cost to a minimum and to facilitate fabrication by handicapped workers thereby increasing the scope of job opportunities for these people. The envelope, or case of the input device will be made of reinforced plastic or other light, shock absorbent, economical and easily fabricated material. The unique design of the switching system will permit rearrangement of keys on the keyboard without breaking interconnections, or extensive disassembly. The assembled and packaged input device assembly will weigh less than ten pounds. Above the keyboard will be located the necessary controls and switches such as the on-off switch, output station selector switch, etc.

2. Readout Device or Tactile Display (See Figure 7). The readout device in its basic form consists of a single cell, six solenoid readout module assembled in a molded plastic case. The case is shaped to accommodate the human hand in such a manner as to prevent fatigue in the hand, and generally to minimize anything which might cause distraction from the tactile reading function. The readout device is connected to the input device or tape storage by a cable containing seven conductors.

The literature indicates that some blind persons utilize more than one finger in reading braille. Provisions will be made in the design concept to allow flexibility in the design of the output device to enable more than one group of six solenoids to be included in the output device, increasing thereby the perceptual span of the braille reader. The keying circuit of the switching complex would then be designed to yield a proper signal distribution to the braille cell (output device) modules that would duplicate the procedure ordinarily followed in the reading of a standard braille book. This also becomes significant when programming a magnetic tape with braille signals when the use of multiple track recordings are considered. Utilizing a multiple track recording,

the tracks will simultaneously and in proper sequence activate as many braille cell output heads as there are individual tracks on the magnetic tape. If four tracks are used, for example, the blind reader may then sense the braille signals with four fingers on corresponding braille cell output positions thereby increasing his perceptual span.

Design Criteria for the Readout Device

The readout device, or tactile display may be actuated directly by the input device or by means of a magnetic tape encoded with braille signals. When the magnetic tape is used, certain control elements are necessary. The controls are located on the side of the output device case and in a position accessible to the thumb and index finger of the right hand. Three control elements will be used. These elements will function as follows:

Button No. 1—Intermittent or continuous readout

a. Single cell advance. Press button with thumb and release. The braille cell presentation (rising or sensor pins) on the sensor plate will remain until the button is pressed again. See Figure 7a. When this occurs a new braille cell presentation will appear.

b. Steady and continuous readout; controlled rate of presentation. Press button in and forward with thumb. The button will stay in the detent position until it is released by pushing it backward and removing thumb.

Button No. 2—Intermittent or continuous reversal

a. Single cell reverse. The function is the same as for button No. 1a above except readout is in reverse.

b. Multiple cell reverse. The function is the same as for button No. 1b above. The magnetic tape will rewind continuously at a controlled rate which will enable back tracking of the braille presentation.

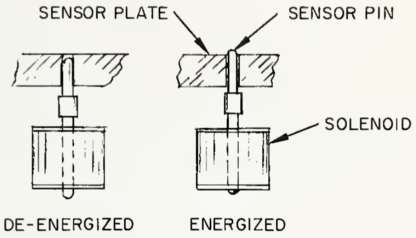


Figure 7a. Action of solenoid.

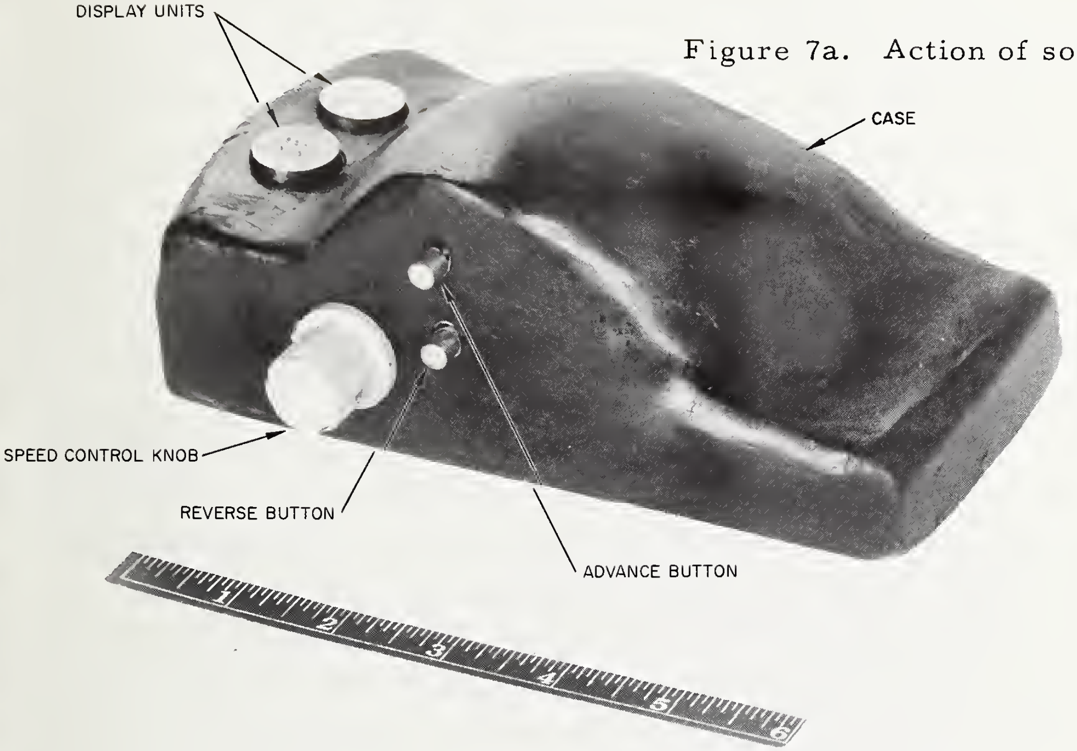


Figure 7. Tactile display mockup.

Speed Control Knob

The speed control knob is connected to a potentiometer in the case of the readout device. The knob is used for controlling the forward indexing and the reversal speed of the magnetic tape. This allows for adjustment of braille cell presentation rate to suit the reading ability of the blind reader.

Development of tactile presentation concept must be accompanied by compatible methods for controlling readout rates and ways to adjust the "intensity" of the display because the blind readers will vary in their individual levels of tactile acuity. In general, the braille teaching and communications system is intended to achieve a duplication of the sensations encountered in braille reading due to the movement of the hands across the embossed page. The hand will remain stationary however when the tactile display device is used. This is intended to eliminate the mental effort and the time normally consumed in scanning and seeking the braille cell configurations on the printed page. Experienced readers of braille use both hands and several fingers as an aid in locating the letters and assuring the continuity of information transfer.

The feasibility of the Braille Teaching and Communications System will have to be determined through evaluation by blind and deaf-blind subjects and braille reading specialists. An increase in the reading rate by the blind reader as well as the enhancement of his comprehension of the subject material are anticipated through utilization of the system.

Applications of the Braille Teaching and Communications System

The input and readout devices in combination will be used for direct communication or for teaching. A single instructor can teach several students when each student is equipped with a readout device. An additional array of selector switches will enable the instructor to select one or more students at random to communicate with them directly. Intercommunication between students will also be effected.

Direct communication with a deaf person is also possible with this system. Moreover, it is proposed to design the system to permit use of a standard telephone transmission system for linking the input

device to the tactile display. A two-way communication arrangement would apply here. Details on this phase of the development program will be discussed after feasibility studies and device evaluation have resumed on the input and readout devices.

Marketability of the Braille Teaching and Communication System will be assured when additional application capabilities are generated for the system. Special applications will be considered offering to the blind a wider scope of social and economic opportunities. The applications involving blind persons can apply also to sighted persons because the system represents another mode for transmitting and receiving information and can be properly applied under specified circumstances.

A specific application of the tactile display device concerns a tactile readout of numerics. The digits from zero to nine are represented by specific configurations of the upper four dots on the braille cell. The output of a digital voltmeter for example, is presented ordinarily on a visual display employing "Nixie" tubes or similar components. The output of the digital voltmeter may also be connected through the necessary circuitry to the tactile display device. The numerical readout may be presented by either of the following procedures:

1. Single cell tactile display: The numerical readout is presented in sequence just as the number would be read visually. The braille representation would be generated one digit at a time.
2. Multiple cell tactile display: The number of braille cells on the readout device correspond to the number of digits ordinarily presented by the digital meter. A four digit visual display would then be represented by a tactile display device having four braille cell outputs and the number would be read with four fingers. In a similar manner all types of instrumentation having alphabetical or numerical displays can, with suitable modification, be adapted for readout with the tactile display device. Standard Grade Two braille alphanumeric coding may be used, or if the application permits, a specialized code would be presented. Typical

instrumentation would include dial indicators, ammeters, vacuum and pressure gages, temperature indicators, etc. On the magnetic tape used for teaching, an audio track can be integrated with the braille signal to aid in teaching students without the presence of an instructor.

Availability of Components

Several manufacturers of electromechanical and electronic components have already been contacted and some have submitted samples of relays, solenoids, switches and technical literature. Components of high reliability, meeting military specifications or otherwise stringently qualified will not be specified whenever functional requirements permit. Standard, off-the-shelf proprietary components and hardware, interchangeable as to manufacturers and overall physical and electrical ratings will be specified wherever possible.

Due to the basic requirements for the input device switching complex, this unit is expected to be the more expensive of the units in the system because 63 keying positions are called for. Vendors of data processing equipment are being sought as sources for keyboard assemblies.

ACKNOWLEDGMENT

Special acknowledgment is given to Mr. Leonard Berling who was formerly a practicing attorney-at-law in Chicago, Illinois. Mr. Berling, who lost his sight several years ago, is now residing in Los Angeles, California. He is currently engaged as an instructor in braille reading and also is active as a transcriber of music into the braille form. The subject proposal for the Braille Teaching and Communication System was the result of discussions prior to December 1963 with Mr. Berling on existing braille reading and teaching devices. He was instrumental in assisting in the formulation of the proposed system. He has a continuing interest in the project and expressed willingness to assist in the evaluation of forthcoming prototype hardware.

CORRESPONDENCE

Background information regarding the various problems associated with reading and teaching of braille was obtained from several sources. Some of the related correspondence have been reproduced and copies thereof are included at the end of this report.

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APPENDIX I

A GLOSSARY OF TERMS RELATED TO THE BRAILLE TEACHING AND COMMUNICATIONS SYSTEM

GLOSSARY OF TERMS RELATED TO THE BRAILLE TEACHING AND COMMUNICATIONS SYSTEM

Actuator, Solenoid

An electromechanical device consisting of a case containing a coil of wire cylindrically encompassing a loose fitting iron core which moves axially when electric current passes through the coil.

Acuity, Tactile

A measure of keenness by which information can be discerned through the sense of touch.

Advance

Changing of the cell configuration to a succeeding form in the generation of the information pattern.

Bit

The information denoted by the given dot configuration in the braille cell.

Blindness, Adventitious

Gradual or sudden blindness inflicted on a sighted person.

Blindness, Congenital

Blindness occurring before birth and usually manifesting itself for the life span of the person.

Book, Talking

Transcription of written or printed material into spoken form utilizing disc or tape recording as the storage mode.

Braille

A system of printing and writing for the blind, in which letters, numerals and punctuation are made of raised dots distinguishable by the fingers.

Cell, Braille

A group of six dots arranged in two vertical columns of three dots per column and numbered from top to bottom and left to right from one to six successively.

Cybernetics

A science dealing with the comparative study of complex electronic calculating machines and the human nervous system in an attempt to explain the nature of the brain.

Discrimination, Tactile

The ability to distinguish and classify bits of information utilizing the sense of touch.

Display, Tactile

The braille cell configuration as presented for tactile contact.

Dot

The individual point; six of which comprise a braille cell. Each dot is identified by its specific location in relation to its neighbors in the cell. See braille cell.

Homing

The movement of the fingers in seeking contact with the braille cell.

Input Device

A keyboard resembling a typewriter keyboard and consisting of a switching complex. Each key represents a standard braille character.

Matrix, Tactile

Surface arrangement where portions are raised as desired to indicate lines or surfaces in depth.

Perceptual Span

The indiscriminate mass of information sensed by the sensing organ just prior to analysis by the brain.

Perception, Tactile

The ability to identify the dot configuration of the braille cell by contacting the cell with the finger.

Presentation

The specified configuration of the braille cell representing a letter, number, punctuation mark, etc.

Presentation Rate

The rate expressed as words per minute or cells per second at which the readout device can generate the cell form.

Projection

The distance measured in parts of an inch to which the top of the dot extends above the reference surface on a braille cell.

Readout, Braille

The configuration of the dot presentation of the braille cell as it appears on the tactile readout device.

Readout, Digital

See tactile readout device.

Readout Device, Tactile ("TRD")

A mechanical or electromechanical device containing a mechanism which causes projections on a sensing surface to rise above that surface in a predetermined order and in patterns representing specified braille cell configurations.

Reference Surface

The surface of the braille cell touch plate above which the dot projects. See projection.

Relay, Latching

An electromechanical device in which the contacts are held in the pulsed position, mechanically or electromechanically, until the condition is reversed by a succeeding pulse.

Repeat, Multiple Bit

The reversal of the readout process involving the repetition of two or more cell configurations.

Repeat, Single Bit

The reversal of the readout mechanism involving the repetition of a single cell configuration.

Replication

A copy or reproduction.

Scanning

Movement of the fingers along the cells on the embossed page of braille characters.

Sensing, Multidigital

The use of 2 or more fingers in sensing the related number of braille cells.

Signal Mode

Manner of signal presentation such as tactile, audible or visual.

Tactile

The display from that can be perceived and identified by the sense of touch.

Touch Plate

The surface portion of the tactile readout device on which the braille cell configuration is located.

Threshold, Tactile

A measure of the level of tactile acuity of an individual. The point of sensitivity at which the braille cell configuration can be determined.

Transcribing, Braille

Converting of written or printed matter into braille form representing the corresponding letters.

Visualization

The ability to form a mental image of form and spectral relationships in two and three dimensions.

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